A camera and hook system for viewing and retrieving rodent carcasses from burrows

Kurt VerCauteren, Michael J. Pipas, and Jean Bourassa

Abstract Research to evaluate rodenticides often requires determining bait efficacy, retrieving carcasses of poisoned rodents for chemical analyses, and quantifying nontarget and secondary hazards and mortalities. Traditional methods of retrieving carcasses from burrows (telemetry and excavation) are expensive and inefficient. Further, they do not address non-target issues. Researchers need more innovative and effective methods to locate and retrieve poisoned fossorial rodents. Information on the distance at which rodents die from the entrance of their burrows is also needed to assess secondary hazards to scavengers. We evaluated a burrow-probe camera and hook system for viewing inside burrows and retrieving carcasses of poisoned California ground squirrels (*Spermophilus beecheyi*). We probed 654 burrows and found 31 rodent carcasses within 2 m of the burrow entrance, 23 of which we retrieved. We found carcasses at a mean depth of 1 m (SE =0.07, n=31), too deep to be available to most surface avian or mammalian scavengers. Average time to probe 50 active burrows in 1- to 4-ha plots was 2 hr 24 min (SE=17, n= 11). The system was also useful for collecting descriptive information on live squirrels and nontarget species.

Key words burrow, California ground squirrel, camera, rodent, rodenticide, *Spermophilus beecheyi*, wildlife damage management

Toxic baits are often used to control burrowing rodents in agriculture and rangelands. Research to evaluate the impacts of rodenticides often requires evaluating killing efficacy and retrieving the carcasses of poisoned rodents for chemical analyses. The Environmental Protection Agency (EPA) requires such analyses to evaluate rodenticide residues and potential secondary hazard risks to species that may consume poisoned rodents. It is also important to determine whether poisoned rodents die close enough to burrow entrances to be available to surface scavenger species. The majority of poisoned rodents die in their burrow systems, and radiotelemetry techniques are commonly used to position the researcher directly above the underground transmitter (Witmer et al. 1995, Witmer and Pipas 1999). Researchers then excavate, by hand or with the aid of a backhoe, the transmitter and carcass (Hegdal and Colvin 1986). Though practiced commonly, this method is very costly (i.e., telemetry equipment, excavating equipment), labor-intensive, and invasive on the landscape. Further, transmitter range decreases greatly the closer it gets to the surface of the ground (Cochran 1980) and even more so below the surface.

A comprehensive literature search of 34 databases yielded only 1 citation in which a burrow camera was used to study mammals (Bassano and Peracino 1997); we found 4 studies focusing on birds. Gervais and Rosenberg (1999), Gervais et al. (2000), and Griebel (2000) studied burrowing owls

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(*Athene cunicularia*), and Seto and Jansen (1997) studied bonin petrels (*Pterodroma hypoleuca*). Kent et al. (1997) used a burrow camera to study gopher tortoises (*Gopherus polyphemus*). All prior studies, with the exception of Kent et al. (1997), used cameras to collect descriptive data only. Researchers need more innovative and effective methods to locate and retrieve poisoned fossorial rodents. To address this need, we evaluated 1) a burrow-probe camera system for viewing inside burrows to collect quantitative and qualitative data and 2) a hook for retrieving carcasses. The goals of our study were to evaluate a burrow-probe camera system for viewing the interior and contents of California ground squirrel (*Spermophilus beecheyi*) burrows and to test the hook for removing carcasses.

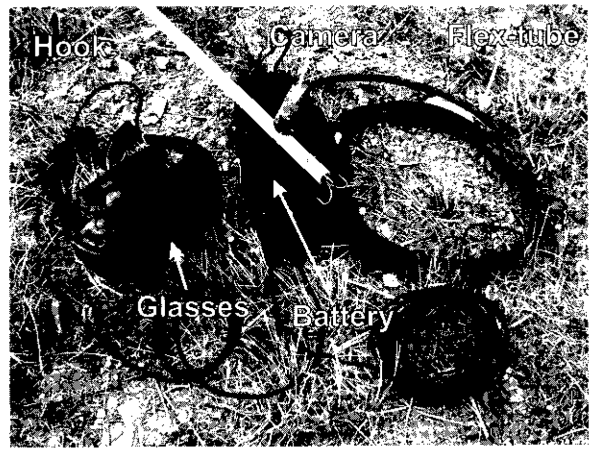

Figure 1. The burrow-probe camera system used for viewing the interior and contents of California ground squirrel burrows and the hook used to remove carcasses. The study was conducted in June 2000 on a ranch in south-central California, USA.

Methods

We conducted this study on a private ranch in south-central California approximately 30 km north of Bakersfield. The site was selected because of its high-density California ground squirrel population and because it was large enough to allow sufficient separation between study plots to prevent re-invasion. Eleven 1- to 4-ha plots were located on the ranch; 9 were randomly chosen to be treated, and 2 served as controls. A Global Positioning System (GPS) and Geographic Information System (GIS) were used to construct maps of the plots, and the boundaries of each plot were marked with surveying flags.

Our camera and hook system evaluation was the below-ground component of a study comparing 0.005% and 0.01% chlorophacinone and diphacinone baits, applied by spot-baiting or broadcast baiting, for controlling California ground squirrels (T. P. Salmon, University of California-Davis, unpublished data). They spot-baited by applying measured amounts of bait by hand around active burrows and along runways. Active burrows were defined as those with fresh squirrel scratching and digging at their openings. They broadcast bait with a seed broadcaster mounted on an all-terrain vehicle. Secondary goals of the baiting study were to assess and compare potential primary and secondary hazards associated with the different baits and baiting strategies. They collected data on residue concentrations in carcasses, above-ground location of carcasses, time-course recovery of carcasses, and above-ground scavenger/predator utilization of carcasses. Our study contributed information and carcasses collected below ground.

We used a Peep-A-Roo Video Probe (Sandpiper Technologies, Inc., Manteca, Calif.) camera (Figure 1). The camera consisted of a lens with a 3.7-mm focal length and 537 horizontal and 505 vertical lines of resolution (Christiansen 2000). Six infrared light emitting diodes (LEDs) provided a minimum of 4-lux illumination. The camera and LEDs were encased in a hard-plastic head. The head was connected to a 3-m-long bi-wound stainless steel flex-tube jacketed in rubber. The camera operator wore video-display glasses to view real-time images through the camera, and selected video footage was recorded with a compact video camera. We draped a dark shirt over the camera operator's head to keep out sunlight and facilitate his seeing images through the glasses. A 12-volt gel-cell battery, mounted on a waist belt, powered the system. The hook units were composed of assorted lengths of 1.3-cm PVC pipe with a size 2 treble hook affixed to one end. When we observed a carcass, a hook was inserted into the burrow and used in conjunction with the camera to see, snag, and extract it from the burrow.

We began viewing burrows and retrieving carcasses 2 days after the site was baited, and it took 5 days to complete all 11 plots. The flex-tube of the camera was marked with colored tape at 1 and 2 m from the camera head. If we were unable to probe ≥1 m into a burrow due to limitations imposed by the burrow's physical characteristics, we added another burrow to the sample for the plot. We assumed that 1 m was about the maximum depth at which squirrel carcasses would be available to surface scavengers and attempted to view each burrow to a maximum of 2 m. As a means of measuring the efficiency of our methods, we documented the time it took to probe each burrow (time from inserting the probe to reaching the maximum attainable depth). We systematically worked across plots, flagging burrows as they were probed. We selected for active burrows that were spaced proportionally through the plot. For each burrow, we recorded the presence or absence of a carcass(es). For burrows containing a carcass(es), we recorded the distance from the burrow entrance at which it was found. All carcasses found within 1 m of a burrow entrance were retrieved, and we made reasonable efforts to retrieve carcasses up to 2 m from the entrance. We attempted to retrieve carcasses with the hook, which sometimes required some excavation with a shovel and spud bar. Each retrieved carcass was placed in a plastic bag, labeled by burrow and plot, and frozen for later chemical analysis by the National Wildlife Research Center (NWRC, Fort Collins, Colo.) analytical chemistry unit.

While probing, we occasionally viewed live squirrels and other species in burrows. We recorded the same information for live squirrels as for dead squirrels, in addition to other qualitative data (e.g., apparent health, reaction to the probe). Besides collecting the carcasses of ground squirrels, we retrieved the carcasses of any dead animals found in the burrows. These carcasses were preserved in the same manner as the ground squirrel carcasses and were later chemically analyzed to address questions on nontarget and secondary hazards of the baiting program. The study protocol was approved by the NWRC Institutional Animal Care and Use Committee (QA-879).

Results

We probed 654 burrows, 104 (16%) of which could not be probed to 1 m and 550 (84%) that were probed to ≥1 m (maximum slightly >2 m). Average depth of probes was 1.4 m (SE=0.02, n=654). Probing depth was dictated by the configuration of each burrow; shallower turns in the burrow allowed us to probe deeper. In cases where a burrow forked, we followed the branch that offered the probe the least resistance. Mean time to probe a burrow was 46.1 sec (SE=1.41, n=654), and mean time to probe ≥50 active burrows in the 1- to 4-ha plots was 2 hr 24 min (SE=17, n=11).

K. VerCauteren uses the burrow camera and hook system.

In the 9 treatment plots, we observed 45 squirrels; 31 were dead and 14 were alive. Of the live squirrels, 9 appeared to be dying and 5 appeared healthy. Dying squirrels showed labored respiration, nearly closed eyes, and allowed themselves to be touched with the probe. In the 2 control plots, all 4 squirrels we observed were alive and appeared healthy. For all 11 plots (9 treatment, 2 control), the mean number of rodents (alive or dead) viewed per burrow was 0.07 (SE=0.01). We found dead squirrels at an average depth of 1.0 m (SE=0.08, n=31). We retrieved 23 (74%) of the dead squirrels, 18 with the hook and 5 by hand. Other species observed while probing included 3 western diamondback rattlesnakes (*Crotalus atrox*), 1 gopher snake (*Pituophis* spp.), a clutch of burrowing owl chicks, 3 side-blotched lizards (*Uta stansburiana*), and 1 dead harvest mouse (*Reithrodontomys megalotis*).

A healthy California ground squirrel in a burrow.

Other species encountered while probing burrows included A) western diamondback rattlesnakes (note dead California ground squirrel in upper right of image), B) side-blotched lizards, C) burrowing owls (image is of a chick), and D) gopher snakes.

Discussion

The burrow-probe camera and hook system had advantages over traditional telemetry methods for finding and retrieving carcasses of poisoned rodents. Studies on rodenticide assessment could be optimized by combining our system with telemetry methods. For example, we were able to collect information on rodent presence or absence in burrows up to 2 m, for a sample of all burrows in the census area, not just a limited sample of radiomarked squirrels. We also obtained information on the behaviors of poisoned rodents in their burrows. We were less likely to observe healthy squirrels because the probe may have frightened them deeper into their burrows. Finally, we viewed and retrieved the carcasses of other species encountered in burrows; this information could provide valuable data on nontarget effects and secondary hazards of rodenticide baiting programs.

The burrow camera and hook system has potential applications to other aspects of wildlife research. It could be used to complement aboveground carcass searches and activity indices. Until now, the structure, form, and contents of burrows and dens of rodents have been examined primarily through excavation (Miller 1957, Sheets et al. 1971, Reichman et al. 1982). The burrow camera allowed the exploration of burrows and dens without destroying them. The burrow camera could also be used to collect data on the internal structure of burrows, target-species behavior and habits, presence of nontarget species, species interactions, and other biological information to a depth of 1–2 m. Because we used infrared LEDs to illuminate burrows, it appeared that organisms in burrows could not detect the light and therefore did not alter their behavior (Kowalski 1976, Borror et al. 1989, McIlwain 1996).

The deeper we attempted to probe, the greater were the limitations of the system. It was difficult to maneuver the camera around sharp turns and up steep grades. When a burrow system branched, we could sometimes direct the camera into a selected branch, but more often the camera followed the main or lower branch. In cases where a burrow floor had deep, loose soil, the camera lens often became blocked. The burrow camera could be improved if the operator had more control of the camera head and if it were possible to penetrate deeper into burrows. The hook could be improved if it had a flexible shaft that could be maneuvered through burrows, thus reducing the need to excavate burrow entrances to reach and hook carcasses.

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